Remarks

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

Thus, claim 1 has been amended in response to the objection to this claim in item 2 on page 2 of the Office Action, by reciting that the method comprises (a step of) withdrawing glyoxal and/or its hydrate from the bottom of the column in the recited amount. This renders the objection to claim 1 moot.

The patentability of the presently claimed invention over the disclosures of the references relied upon by the Examiner in rejecting the claims will be apparent upon consideration of the following remarks.

Thus, the rejection of claims 1-6 under 35 U.S.C. §103(a) as being unpatentable over Sakamoto et al. (US 5,785,821) in view of Mettetal et al. (US 4,358,347) is respectfully traversed.

After discussing the Sakamoto et al. reference, the Examiner acknowledges that the difference between this reference and the instant invention is that the reference does not teach the removal of glyoxal present as impurity in the aqueous solution along with acrylic acid from the distillation tower. The Examiner then states that since Sakamoto et al. teaches the process of removal of acrylic acid by azeotropic distillation, it would have been obvious to one of ordinary skill in the art at the time the invention was made to remove impurity such as glyoxal present in acrylic acid and thereby obtain the present invention.

However, the present invention as set forth in claim 1 (the only independent claim in the application) requires a step of "withdrawing glyoxal and/or its hydrate from the bottom of the column" in the recited amount, which is not suggested by Mettetal et al. (or Sakamoto et al. as acknowledged by the Examiner). That is, Mettetal et al. do not withdraw glyoxal and/or its hydrate from the bottom of the column, but rather, remove a reaction product (believed by Mettetal et al. to be cyclic acetals) resulting from the reaction of glycol with the carbonyl impurities such as glyoxal (column 1, lines 39-43 and column 2, lines 25-43). In contrast to this, the present invention withdraws "glyoxal

and/or its hydrate" from the column bottom, rather than removing a reaction product formed by reacting 1,2-glycols with glyoxal as in the Mettetal et al. reference.

Although the Examiner states that it would have been obvious to remove impurity such as glyoxal present in acrylic acid, the presently claimed invention achieves this in a different way than the Mettetal et al. reference, as indicated above. That is, as explained above, Mettetal et al. removes the glyoxal impurity by reacting the glyoxal with 1,2-glycols to form a reaction product, and it is this reaction product which is removed.

Furthermore, the reference actually indicates that the reaction product "remains in the bottoms" at column 1, lines 42-43; or "remain in the bottoms of the distillation process" at column 2, lines 45-46. This would not suggest the present invention which requires withdrawing glyoxal and/or its hydrate from the bottom of the column.

Applicants also note that the presently claimed invention has particularly advantageous effects, as apparent from the disclosures, for example, at page 3, lines 6-11 and the sentence bridging pages 4 and 5 of the specification. That is, a problem which has been encountered in producing acrylic acid is that during azeotropic dehydration distillation to recover acrylic acid, the acrylic acid tends to polymerize and by-products formed during the production of acrylic acid tend to deposit in the column used for the azeotropic dehydration distillation. The present invention solves this problem by removing glyoxal from the bottom of the column, thus ensuring an effective suppression of the accumulation of the glyoxal (one of the by-products) in the column during distillation, and reducing the accumulation of by-products in the column to allow a continuous operation of the column over a longer period of time. These advantageous effects of the invention are not suggested by Mettetal et al., who instead address the problems of (1) a prolonged induction period in the polymerization reaction, (2) color in the resulting products made from the polymers, (3) crosslinking and (4) chain termination which results in lower molecular weight polymers (column 1, lines 17-24).

For these reasons, Applicants respectfully submit that the presently claimed invention is not obvious from the Sakamoto et al. and Mettetal et al. references.

The rejection of claims 1-4 and 6 under 35 U.S.C. §103(a) as being unpatentable over Sakamoto et al. (EP 0 861 820 A2) as evidence provided by Mettetal et al. is respectfully traversed.

The format for this rejection is essentially the same as in the previous rejection discussed above. That is, after describing the Sakamoto et al. (EP '820) reference, the Examiner acknowledges that the difference between this reference and the instant invention is that the reference does not teach the removal of glyoxal present as impurity in the aqueous solution along with acrylic acid from the distillation tower. The Examiner then relies on the Mettetal et al. reference in the same manner as for the rejection of Sakamoto et al. (US '821) in view of Mettetal et al. Therefore, Applicants' comments set forth above concerning the Mettetal et al. reference are equally applicable to this rejection. Summarizing these comments, Mettetal et al. removes the glyoxal by reacting it with 1,2-glycols to form a reaction product, which would not have suggested withdrawing glyoxal and/or its hydrate from the bottom of the column as required in the presently claimed invention.

With regard to both the prior art rejections, Applicants also note that in the ordinary acrylic acid production process, an aqueous acrylic acid solution is subjected to treatment in an azeotropic dehydration column to separate acrylic acid from a mixture of water and an azeotropic solvent. The crude acrylic acid is withdrawn from the bottom of the column, whereas the mixture of water and the azeotropic solvent is discharged from the top of the column. In this azeotropic distillation of an aqueous acrylic acid solution, glyoxal as an impurity or by-product may be changed into its hydrate, which can easily be condensed in the azeotropic dehydration column under conventional operating conditions. As a result, there may occur deposition of by-products, polymerization of acrylic acid, and formation of tar, thereby causing clogging of the column or bias of flows in the gas and liquid phases in the column. The bias of flows may make polymerization inhibitors unevenly distributed, resulting in occurrence of the polymerization of acrylic acid, as discussed in the present specification, particularly on page 4 thereof.

Taken collectively, the references applied by the Examiner teach the "temperature related reason" discussed in the present specification at page 4, lines 15-18, for problems occurring in the azeotropic dehydration column. For instance, the EP '820 reference discloses that acrylic acid polymer accumulates in the column to render continuous running of the azeotropic separation column over a prolonged period difficult (column 2,

lines 48-50). However, none of the applied references discusses, or even suggests, the "impurity related reason" discussed at page 4, lines 18-20 of the present specification, for the problems occurring in the azeotropic dehydration column, i.e. impurities, especially glyoxal and its hydrates, contained in the acrylic acid aqueous solution which induce the formation of polymerization materials (see page 15, lines 26-27) or impurities themselves which are accumulated and deposited in the column. Applicants have addressed this problem by withdrawing glyoxal and/or its hydrate from the bottom of the column in the recited amount as set forth in claim 1.

Attention is also directed to claim 2 of the present application, which requires that the concentration of water in liquid phases at the 3rd to 6th theoretical plates in the azeotropic dehydration column is 0.1 mass % or more. There is no suggestion of this embodiment of the present invention in any of the applied references.

For these reasons, Applicants take the position that the presently claimed invention is clearly patentable over the references applied by the Examiner in rejecting the claims.

Therefore, in view of the foregoing amendments and remarks, it is submitted that each of the grounds of objection and rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

Kazuo OHKOUCHI et al.

By: 

Michael R. Davis
Registration No. 25,134
Attorney for Applicants

MRD/pth
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
August 17, 2005